Extra Credit 1

CMSY-199, Spring 2011

50 points

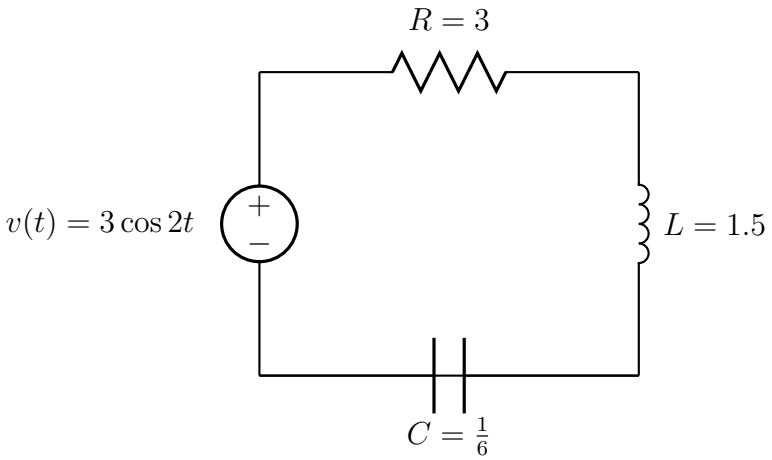
The source code and sample output for this assignment must be submitted electronically using the CE6 course website prior to the start of class on Monday, April 11.

A common application of complex numbers in the field of Electrical Engineering involves converting a real-valued AC Circuit into a complex-valued Phasor Circuit. The Phasor Circuit *greatly* simplifies the solution of the AC Circuit although it does require the manipulation of complex numbers rather than real numbers.

1. Write a class called `PhasorCircuit` which *has* two member variables:
   (a) a double named `frequency`
   (b) a three-element array of type Complex named `impedance`
2. Write a constructor that takes four doubles named `w`, `R`, `L`, and `C`. Assign the argument `w` to the member variable `frequency`. Use the formulas shown in the Phasor Circuit for $\mathbf{Z_R}$, $\mathbf{Z_L}$, and $\mathbf{Z_C}$ to initialize the Complex member variables `impedance[0]`, `impedance[1]`, and `impedance[2]` from the arguments.
3. Write a method called `solveCurrent` which takes an argument of type Complex named `phasorVoltage` and returns a Complex type. Use equation (2) below to compute and return the phasor current, $\mathbf{X}$.
4. Make the `PhasorCircuit` class a Java application by adding a `main` method to:
   (a) Create an instance of type `PhasorCircuit` called `seriesCircuit` using the parameters ω, R, L, and C shown in the AC Circuit below. *Hint:* be careful not to perform integer division when computing C.
   (b) Create an instance of type Complex called `phasorVoltage` with the value of the phasor voltage, $\mathbf{V}$, in the Phasor Circuit below.
   (c) Print the phasor current by calling the `solveCurrent` method of the `seriesCircuit` object with `phasorVoltage` as the argument.

AC Circuit

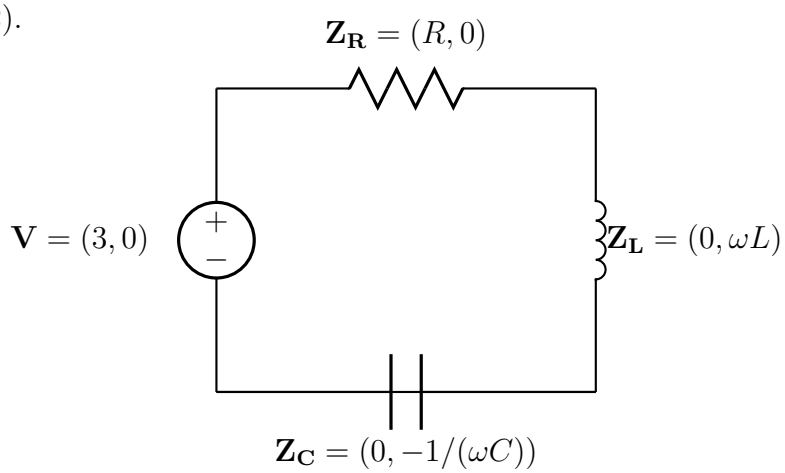
An AC Circuit with an ideal voltage source of $v(t) = 3\cos 2t$ volts is connected in series to three circuit elements - one $R = 3$ ohm resistor, one $L = 1.5$ henry inductor, and one $C = \frac{1}{6}$ farad capacitor. Note that the frequency of the voltage source is $\omega = 2$ radians/s. The resulting current, $x(t)$ amperes, is given by the differential equation (1).



$$\frac{\mathrm{d}^2x(t)}{\mathrm{d}t^2} + \frac{R}{L}\frac{\mathrm{d}x(t)}{\mathrm{d}t} + \frac{1}{LC}x(t) = \frac{1}{L}\frac{\mathrm{d}v(t)}{\mathrm{d}t} \tag{1}$$

Phasor Circuit

The corresponding Phasor Circuit has phasor voltage $\mathbf{V} = (3, 0)$, resistor impedance $\mathbf{Z_R} = (R, 0)$ ohms, inductor impedance $\mathbf{Z_L} = (0, \omega L)$ ohms, and capacitor impedance $\mathbf{Z_C} = (0, -1/(\omega C))$ ohms. The resulting phasor current, $\mathbf{X}$ amperes, is given by the algebraic equation(2).



$$\mathbf{X} = \frac{\mathbf{V}}{\mathbf{Z_R} + \mathbf{Z_L} + \mathbf{Z_C}} \tag{2}$$

After solving for the phasor current, the current in the original AC circuit is given by equation (3).

$$x(t) = \mathrm{Re}[\mathbf{X} \cdot (\cos 2t, \sin 2t)] \tag{3}$$